SCIENCE:

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JOHN MICHELS, Editor.

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The International Electrical Exhibition at Paris was opened with much *éclat* on the 10th instant by the President of the French Republic.

The brief telegraphic dispatches describing the event, all state that Edison's exhibit was the chief centre of attraction, and that great interest was shown for the forthcoming exhibition of certain novelties which he had sent. These appeared to prove that the energies of the great electrician were far from exhausted on this subject, and that his fertile brain is as active as ever.

We are promised a very detailed report of this exhibition, so defer particulars until it arrives. England and Germany occupy the largest space of the foreign countries represented, America and Belgium coming next in order. All the departments on the day of opening were incomplete, the Americans complaining much of the dilatory behavior of the French workmen, who seemed to have no idea of the value of time.

We presume that the object of exhibitions of this character is to stimulate those engaged in electrical investigations, and to form landmarks in the history of electrical progress. In that light the Exhibition has many advantages, but Edison appears to have suffered from his generous permission to permit all comers to inspect the progress of his inventions. Many misinterpreted what they saw, and came to false conclusions, while men of no mental endowment who were mere clever mechanics, assiduously appropriated the ideas of the man of brains, and have since produced barefaced copies. These men have so far proceeded unchecked, but the time appears to have arrived when Edison has decided to enforce with vigor all those patent rights which he has secured after so many years of patient study and unremitting toil, involving the outlay of an immense amount of money.

The seizure of the "*Maxim*" electric lamps at the Paris International Exhibition appears to have been directed in consequence of such a decision, and we can assure Mr. Edison that the public will heartily sympathize with him in his attempt to enforce his just rights.

WE are informed by cable that Sir George Biddell Airy has retired from the office of Astronomer Royal, and his successor appointed.

Sir George was born on the 27th of July, 1801, and was elected a Fellow of Trinity College in 1824. He commenced his career as a scientific teacher in 1826, when he was elected Lucasian Professor. In 1828 he was elected Plumian Professor, and entrusted with the management of the Observatory at Cambridge which had been just then erected and supplied with one of its instruments. On taking charge of the new Observatory he commenced a series of observations, but his able services there will be best remembered by the admirable methods he introduced in the calculations and observations, by which their utility was greatly increased.

Professor Airy had also the satisfaction of superintending the mounting of the Equatorial, the Mural Circle and the Northumberland Telescope (the last entirely from his own plans), at the Cambridge University.

In the autumn of 1835 the office of Astronomer Royal became vacant by the resignation of Mr. John Pond, and at the request of Lord Auckland, Airy received the appointment for this distinguished office, which he has since filled with so much benefit to science and honor to his country, for a period which has covered nearly half a century.

In 1833 he received the gold medal of the Royal Astronomical Society "for his discovery of the long Inequality of Venus and the Earth;" and again in 1846, for his "Reduction of the Observation of Planets made at the Royal Observatory, Greenwich, from 1750 to 1830."

WE have the pleasure of directing the attention of our subscribers to a very interesting work by A. B. Hervey, A. M., on "*Sea Mosses*," being both a collector's guide and an introduction to the Study of Marine Algæ. It is published by S. E. Cassino, of Boston. In another part of this issue will be found an extended extract from this book, giving Mr. Hervey's methods of collecting and preserving specimens, and the article will, doubtless, be read with interest at this season, when so many are at the seashore, with full opportunities for commencing the study of this department of Cryptogamic Botany.

SEA MOSSES—TIME AND PLACE FOR COLLECTING.*

Most collecting on our Atlantic coast will be done during the summer and early autumn months. But I must remind those of you who live by the sea, or have it accessible at all times, that many things of the greatest beauty and interest will be missed if you do not go to the shore early. Our finest *Callithamnion C. Americanus* can be had in its rarest beauty early in March and even in February. The finest varieties of our *Rhodomela subfusca* are only to be found in the early spring months. This is true of many other plants. You will be surprised, also, to see what quantities of things you can find as late as November and December. Indeed, if you are to know these plants thoroughly, you must collect them at all seasons of the year. Then you will know when they come and when they go, and when they are in their greatest perfection. Those living and collecting on the Pacific coast are not fenced away by an icy wall, as we are on our shores during two or three months of our hard, inclement winters; so they can collect the year around. Dr. Anderson assures me that most of them are more beautiful and of more luxuriant growth during the Summer than during the Winter months. In general, there are three principal places for collecting "Sea Mosses" by the shore.

First, from the mass of material which the sea throws up upon the beaches, and leaves behind it when the tide goes out. This will be your main resource for getting the plants that grow in deep water. By many causes they will be loosened from their holdings in the depths, and will then float up to the surface and margin of the sea, and will be cast on shore. By carefully turning over these masses, which will be found along almost every sandy or pebbly beach, you will be able to get plants which could otherwise be found only by dredging in deep water. And, by careful search, too, among this material you will find all the deep water forms.

Second, upon the rocks and in the tide pools when the tide is out.

You can collect living plants in their native homes here only. Of course, no Algæ grow upon the sandy beaches. You must, therefore, seek all such as grow between the tide-marks upon rocky shores. Put on a pair of stout rubber boots, and go two or three hours before low tide, and search in every place, following the tide down to its farthest retreat. Many of the best things are found close down by low water mark, and some a little below that. These latter can be got best by taking advantage of the extreme low run of tide which comes about "new" and "full moon." The advantage of going before low tide and following the retreating water down is that you are not so apt to get a drenching, by the unexpected advance of a great wave, as when the tide is coming in; for, if you are close by the water's edge when the tide is rising, busily intent upon getting your floral treasures, you will very likely find yourself soaked with brine, for

> "The breaking waves dash high
> On a stern and rock-bound coast."

In hunting through the tidal region for plants, hunt everywhere, and collect everything found growing, and when collected, like Captain Cuttle, "make a note of it." If you cannot remember without, carry a small memorandum book and enter in it the habitat of each particular kind as you collect it. The tide pools, that is, the little basins in the rocks out of which the water is never emptied, are the places where the choicest collecting may be had. And the nearer they are to the low tide limits the more likely they will be to have abundance of vegetable life in them. But do not fail to look, also, under the overhanging curtain of "Rockweed" which shadows the perpendicular sides of the cliffs and great boulders. You will often find some beautiful plants there, as, for instance, the *Ptilota elegans*, the *Cladophora rupestris* and other smaller "mosses."

Third, by standing on some low, projecting reef, by the side of which the tide currents rush in and out, you will see many of the more delicate, deep water forms, all spread out beautifully and displayed in all their native grace, carried past, back and forth, in the water. Many of these, like the *Polysiphoniæ*, are seldom thrown on shore in good condition, or if they are, do not long remain so. This, therefore, is by far the best place to take many of these plants. To do this you must be provided with some simple instrument for reaching down into the water, and seize them as they go floating by. I have found nothing more convenient for this than a wire skimmer, which can be got at any house-furnishing tin shop, tied with a stout string to a light, strong stick, five or six feet long. The water passes through the meshes of this with little resistance, but the Alga, with its delicate branches thrown out widely in every direction, is very readily caught by it. It will also serve to a limited extent as an implement for detaching plants from their holdings which grow in deep tide pools, or in the sea, not too far below low water mark. For the rest of your

COLLECTING APPARATUS

you may have as little or as much as is convenient. A simple basket or box, with a few newspapers in it to wrap up and keep somewhat separate the different sorts of your collectings, will do very well. If it is convenient, have a case made with a half-dozen or less wide-mouthed bottles set in it, each provided with a cork. The case should also have a compartment for storing coarse plants, newspapers, paper bags, or whatever you may use for keeping different species, or the plants from different localities separate. Then, as your plants are collected, they may be roughly sorted and put in different bottles. But two or three bottles should be reserved for the most delicate and fragile forms. And as there are several of them which rapidly perish on being exposed to the air, the bottles should be kept partly filled with sea-water. The more delicate *Polysiphonias*, the *Calithamnions*, *Dasyas*, and some others, will need this protection. I have found a quart fruit-jar very handy. I get the kind that I can fasten a string around the neck, so as to carry it suspended in one hand, which leaves the other always free to gather in the plants with. A jar, whose cover goes on and off with the least possible trouble, is the one to be selected. The only disadvantage in using a receptacle of this sort for your collection is that in climbing over the wet and mossy rocks, your feet may chance to slip, and you get a tumble; then, in your efforts to save yourself, you will forget all about your fragile glass jar, and will smash it into a thousand pieces, upon the hard stones, and perhaps lose your whole collection. But two or three of these jars carefully packed in a basket, so as not to be easily broken, would perhaps, furnish as handy a collecting apparatus as you could extemporize at the sea shore.

MOUNTING AND PRESERVING.

For "floating out" your "Sea Mosses," as it is called, you should have a pair of pliers, a pair of scissors, a stick like a common cedar "pen stalk," with a needle driven into the end of it, or, in lack of that, any stick carefully sharpened; two or three large, white dishes, like "wash bowls," botanists drying paper, or common blotting-paper, pieces of cotton cloth, old cotton is the best; and the necessary cards or paper for mounting the plants on.

You will use the pliers in handling your plants in the water. The scissors you will need for trimming off the superfluous branches of plants which are too bushy to look well, when spread upon the paper, and to cut away parasites. The needle should be driven point first, a considerable distance into the stick, so as to make it firm, and

* From *Sea Mosses*—by A. B. HERVEY—S. E. Cassino, Boston.

allow you to use the blunt end of it in arranging the finer details of your plant on the paper. For drying paper, of course, you can use common newspapers, by putting many thicknesses together; and a great many, no doubt, will do that. But sheets of blotting paper will be found much more satisfactory; twenty-five of them cut into quarters would probably be all you would use, and those you could easily take in your trunks. What will be found cheaper and still more serviceable, if you are going to mount a large number of plants at once, is a quantity of botanist's "drying paper." It can be had of the "Naturalists' Agency," 32 Hawley street, Boston, Mass., for, I believe, $1.25 per 100 sheets; probably also of other sellers of Naturalists' supplies in all the large cities on both sides of the continent. It is a coarse, spongy, brown felt paper, cut into sheets 12 × 18 inches, and has a fine capacity for absorbing moisture. For convenience, the cotton cloths should be made the same size as the drying paper used. Some collectors, who do not care to mount a great number of specimens at once, but want to have them very smooth and fine, when dry, use no drying paper at all, but in the place of it, have thin smooth pieces of deal, got out a foot or so square and one-quarter or one-third of an inch thick; upon these they spread one or more layers of cotton and lay the plant on them and put as many more over it; the cotton absorbs the moisture and the boards keep the pressure even and the papers and the plants straight and smooth throughout. For "mounting paper" each one must use his own taste. Many prefer cards cut of uniform size; they can be had at almost any paper store or job printing office made to order. Four and a half by six and a half inches, is a neat and convenient size. But if you want to mount several hundred or several thousand spceimens, in the course of a season, so as to have some to give to your friends, and to make up a number of books or albums, to sell at Church or Charity fairs, then perhaps the expense will be an item worth considering. In that case you will find it cheaper to buy a few quires of good 26 or 28 pound demy paper, unruled of course. The paper is in unfolded sheets 16 x 21 and will cut into convenient sizes for mounting any plants ordinarily collected. By halving it you have sheets 8 x 21, or 10½ x 16 inches. By quartering, the sheets are 8 x 10½ inches; halving these you get an octavo sheet 5¼ x 8 inches, which is quite large enough for the majority of plants. One half of this will give a sheet 4 x 5¼ inches which will be the size most used; while the smallest plants look best on the half of these sheets, 2½ x 4 inches.

With your large white dishes filled near to the brim with sea water, or, if you are away from the ocean with water made artificially salt, take a few of your plants from the collecting case, and put them in one of the dishes. Here, handling them with your pliers, shake them out and clean them of any adhering sand or shells, trim away parasites and superfluous branches and generally make them ready for "floating out." Thence, transfer them to the other dish. Then take your card or your paper, selecting a piece large enough to give the plant ample room, and leave a margin of white all around, and having dipped it in the water put it quite under the floating plant, holding the paper with your left hand and managing it with your right. Now float the plant out over the paper and draw the root or the base of it up near the end of the paper next your hand, so that you can hold it down on the paper with the thumb of the left hand, the rest of the hand being under the paper in the water. Now, slowly lift the paper up to the surface and draw it out of the water in such a way that the water will flow off from it in two or three directions. This will spread the plant out somewhat evenly over the paper. But in many cases you will need to arrange the plants in their most natural and graceful position, and also take care that they do not get massed upon each other, and make unsightly heaps while others are left bare. They should be carefully arranged so as to make the most beautiful picture possible. In some fine and delicate plants, too much care cannot be bestowed, in having the remote branchlets all naturally disposed and spread out. This final work of arranging details, you will do with your needle while you hold the paper very near to the surface of the water with your left hand, so near, indeed, that there will be just water enough, and no more, above it to float the delicate parts which you are manipulating. Oftentimes it will be found convenient, after the paper with the plant on it has been removed from the water, to re-immerse a part of it at a time and re-arrange the several parts separately. But all this can easily be done, more easily than I can tell how to do it. A very little practice will give you the "knack" perfectly. And, indeed, these plants are by no means refractory, or hard to manage. They will do anything you can reasonably want them to, while you humor them by keeping them in their native element. In fact, you will commonly need to do no more with them, than to just help them to do what they are willing and disposed to do themselves. For if you will let them take on your paper the form and outline which they have by nature in the water, there will be nothing left to desire, for their color, form and movement all combine there to make them the loveliest and most graceful things that grow. When you have put the last finishing touches upon the "floating" process and your "Sea Moss" is adjusted on your paper so as to be "a thing of beauty and a joy forever," then you want to lay the paper upon some inclined surface—any smooth board will do—to drain away the superfluous water. Thence it is to be transferred, in a few moments, to the press, for drying.

This is made in the following manner: Laying down one of the above descrined sheets of blotting paper, botanists' "drying paper" or boards of muslin-covered deal, you lay your paper with the plant on it upon this, the plant up. Cover the board or drying paper all over with "floated" specimens in the same way. Over all, and lying directly upon the plants spread your piece of muslin. Upon this put another sheet of the paper, or board, and upon this again a layer of plants, then a piece of the muslin, more paper, plants, muslin, and so on until you have disposed of all your collection, or so much of it as you care to mount. Upon the last layer of plants put a final sheet of paper, and over all a stout board as large as the drying paper. Upon this lay some heavy weights—stones will be as handy as anything at the seaside. I should put on, I think, about fifty pounds of them if I were using botanist's drying paper, which has a good deal of give in it. With the use of boards, unless there are a good many thicknesses of muslin, it would not do to weight it so heavily, or some of the plants would be crushed beyond recognition. I use the drying paper and always have two boards, one for the bottom and one for the top of my press. Then when I have made the pile complete, I can put it aside in some convenient corner out of the way, and set the stones to work bearing down upon it, a business for which they seem to have some conspicuous and weighty gifts.

Some botanists recommend that the drying paper be removed in the course of five or six hours, and the cloths and papers again in twenty-four hours. This will, perhaps, be the best if anyone has plenty of time. But my practice has always been to let them lie twenty-four hours and then give them a change of both cloths and papers, being careful in removing the cloths so as not to lift the plants from the mounting paper.

The second time in the press they should be subject to a harder pressure, seventy-five or one hundred pounds of stone being not too much. In twenty-four hours more most of them will be quite dry and ready to be put into your herbarium, album, or whatever you use for the final disposition of them. Those that are not perfectly dry should be put back in the press with dry papers and cloths for another day's stay.

When the plant is perfectly dry and removed from the press you should, before putting it away and forgetting these facts, write on the back of the paper the exact date and place of collecting.

People often ask me what I use to make the plants stick so firmly to the paper, supposing, evidently, that it is necessary to have some kind of gum or mucilage for that purpose. I have to answer that I have for most of them to use nothing whatever; that there is sufficient gelatinous matter in the body of the plant to make it perfectly adhere to the paper without other aid. And the reason for putting the muslin over the plants in the process of pressing and drying is, that they may not stick to the drying paper which is above them, the muslin not adhering to the plants at all except in some few cases.

But a considerable number of "Sea Mosses" do not adhere to paper well. They either have not gelatinous matter enough in them or will not give it out to glue their bodies to the paper. Various devices are resorted to in these cases. Sometimes the plant, after being dried in the press in the usual way, is simply strapped down with slips of gummed paper. Sometimes they are fastened down with some kind of adhesive substance, after being dried, gum tragacanth being the best for this. Others take them and float them out a second time in skimmed milk and after wiping off the milk from the paper, from the plants, except directly under the plants, put them in the press to dry again, when, it is said, they stay. I have never tried this method. A friend of mine who is famous for the artistic way in which she always "lays out" her "Sea Mosses" tells me that for these forms which lack what the Phrenologist might call "adhesiveness" she prepares from the "Irish Moss" *Chrondus crispus* a semi-fluid paste, into which she dips them before putting them on paper, and then carefully removes all of it from the paper and plant, except what is between the two and then put them in the press. By this means they are made to stick "like paper on the wall."

In preparing the coarser "Rockweed" and "Kelp" for the herbarium, another method will have to be persued. These will almost all turn very dark, or quite black, in the process of drying. I am accustomed to treat them by the following method: Taking them home, I spread them out in some shady place and let them lie for a few hours, perhaps twenty-four, perhaps less or more, until most of the water in them has evaporated, but not till they have become hard, stiff and brittle. Then I put them between sheets of drying paper and lay them in the press, and keep them there until the process of drying is complete. A little practice will be the only way by which you will be able to tell if they have been dried long enough in the open air. If you find them inclined to mould while kept in the press, you may be sure they are not dry enough, throw them away and get some new ones.

It is sometimes desirable to keep the treasures we have gathered from the sea unmounted, that we may carry them away to await a more convenient season for floating them out, or that we may send them to some friend or correspondent on the other side of the continent, or beyond the seas. It is, therefore, fortunate that all but the more delicate and perishable of these plants, may be dried rough, rolled up and kept any length of time, transported around the world, and then, when put in water again, will come out in half an hour, as fresh and bright and supple and graceful as they were when taken from their briny home. The friend just referred to assured me that even the *Callithamnia*, *Dasyæ* and the most delicate *Polysiphoniæ*, and such like plants, may be so treated by first shaking the water out of them, and then thoroughly mingling them with dry seasand, and drying them rough in the usual way. She says the sand will adhere to the most delicate fibres and ramuli of the plant in such a way as to keep them separate and prevent their getting glued together, then, when they are afterwards soaked out, the sand will be disengaged, and the plant will be left as good as ever it was. Perhaps I ought to suggest that "soaking out" should always be done with salt water, unless you know you have only those plants which fresh water will not hurt. When I have had specimens of the "Rockweed," or "Kelp," sent to me "rough dried," I have found it best to prepare them for mounting, not by immersing them in water, and so get a great quantity of moisture into them, which would have to be expelled afterwards, with no little trouble, but by wrapping them about with wet towels; from these they would imbibe enough dampness to be manageable, and not enough to make them troublesome.

Before taking leave of this part of my subject I must permit myself to add a word to a point which botanists commonly think too little about, viz., the display of taste in the mounting of their plants. To the mere botanist a plant is a *specimen* of a given genus and species, interesting only for that fact. If it is a full grown typical form with fruit, all the better. Now, all are not botanists. Most of those who will read these pages will have an interest in these plants, to which the scientific interest will be secondary. I want to say then to them, look for the best things; get the whole plant when you can, but get and preserve the most perfect and beautiful plants. It is the rule with botanists to put but one species on each paper or card. I certainly advise disregarding this rule, unless you are mounting for scientific purposes altogether or chiefly. With numberless shades of red, which one group of "Sea Mosses" will give you, with the various kinds of green the other two will present, you will have an opportunity to display all the taste and skill you are master of. For in combining several different colors and forms on the same paper you may often produce the most brilliant results. A little practice will soon make you able to handle two or three plants at the same time in "floating them out" almost as readily as you can manage one. Then, again, you will find it possible with some of the more slender plants to work interesting and beautiful "designs" in the same way. Initial letters, even monograms, may not be beyond your reach with a little care and practice. Let the "Sea Mosses" contribute to the cultivation of every faculty and all possible means of pleasure for you.

For preserving your treasures after they are neatly mounted, pressed and dried, you have two courses open to you. You can take care of them as the botanist does by arranging them systematically in a herbarium, with covers of stout manilla paper, folded 10½ x 16 inches for each genus, and the species separated by white sheets of thinner cover, or you can provide yourself with blank books, made for the purpose, having the leaves cut to fit the sizes of paper or card which you mount your plants on, so as to slip the corners of the cards into the cuts. It is well in that case to provide a book with leaves large enough to hold two or four cards each. By following the directions here given I cannot doubt you will soon become a successful collector, and an expert in mounting and preserving "Sea Mosses."

ACCORDING to M. Chappuis (*Bull. Soc. Chim.*) the phosphorescence of phosphorus vapor by ozone. Phosphorus is not luminous in pure oxygen at 15°, and at the ordinary pressure, introduction of a trace of ozone causes luminosity; those substances which hinder the luminosity of phosphorus, *e. g.* turpentine oil, are substances which destroy ozone. If a little turpentine oil is brought along with phosphorus into a tube containing pure oxygen, and a small quantity of ozone is then passed in, the phosphorus exhibits luminosity for a few moments only; M. Chappuis supposes that this is due to the combustion of phosphorus vapor by the ozone, and that the transiency of the phenomenon is explained by the rapid removal of the ozone by the turpentine oil.

THE ROTATORY POWER OF COMMERCIAL GLUCOSE AND GRAPE SUGAR. A METHOD OF DETERMINING THE AMOUNT OF REDUCING SUBSTANCE PRESENT BY THE POLARISCOPE.

By Prof. W. H. Wiley.

From the Journal of the American Chemical Society, Vol. II.

In "the trade" the name of grape sugar is applied only to the solid product obtained from corn starch. On the other hand, the term "glucose" is given to the thick syrup made from the same material.

I shall use these words in their commercial sense.

INSTRUMENTS EMPLOYED.

I used in the following investigations two polariscopes made by Franz Schmidt and Haensch, Berlin. The readings of these instruments, after correction for displacement, agreed well together.

The one was the instrument ordinarily used, in which the purple ray is employed, and the quartz half moons give blue and red tints.

Both of these instruments are graduated to read 100 divisions, each equal to one per cent sugar with a solution containing 26.048 grms. pure cane sugar in 100 c.c. In addition to this scale the half shadow has another which gives the actual angular rotation.

This is especially convenient when the specific rotatory power of a substance is to be determined. The angular rotation, however, can be calculated for the former instrument.

For if we take the specific rotatory power of cane sugar at 73.8°, we have the following equation:

$$73.8 = \frac{a \times 100}{2 \times 26.048} \text{ whence } a = 38^\circ.45.$$

Each division on the cane sugar scale is therefore equal to 0°.3845 angular measure.

This quantity corresponds to the transition tint. It is different for the differently colored rays. In the half shadow polariscope, an instrument particularly adapted to persons afflicted with any degree of color-blindness, the mono-chromatic light coming from the sodium-Bunsen lamp passes through a crystal of acid potassium chromate. The ray thus produced is less rotatable than the "transition tint."

When the instrument gives 100 divisions on the sugar scale, it shows an angular rotation of only $34°42' = 34°.7$. Our division, therefore, of the sugar scale, is equal to 0°.347 angular measure.

To determine the specific rotatory power of cane sugar for the sodium-acid potassium chromate ray, we use the following equation:

$$\text{Sp. rot. pr.} = \frac{34^\circ.7 \times 100}{2 \times 26.048} = 66^\circ.6.$$

To determine the specific rotatory power for any other substance which has been determined for the transition tint, we multiply by the factor 0.9024.

Thus, if we take the specific rotatory power for any other substance which has been determined for the transition tint, we multiply by the factor 0.9024.

Thus, if we take the specific rotatory power of dextrine for the transition tint at 139°, for the half shadow tint it will be $139° \times 0.9024 = 125°.4$.

These data rest upon the accepted formula:

$$(1)\ \theta = \frac{a}{\varepsilon.\ \delta.\ \lambda}$$

$$(2)\ \theta = \frac{a \times v}{\lambda \times w}$$

Here a = angular rotation.
θ = specific rotatory power.
ε = amount of substance in one grm. of the solution.
δ = specific gravity of solution.
λ = length of observation tube.
w = weight of substance in grms.

MATERIAL.

The glucose studied in the following examinations, was made by the Peoria Grape Sugar Company. I am under obligations to Mr. Allen, the superintendent, for many favors in connection with my work. The grape sugars were made in Buffalo.

ROTATORY POWER.

The average value of θ for the "half shadow ray" is nearly 85°. For the purple ray it is nearly 94°. It however varies extremely in different samples.

The following table will show the range of these variations.

TABLE I.

Showing variations of θ in different specimens of glucose and grape sugar, together with the specific gravities of the same.

No.	Θ	Sp. Gr.	No.	Θ	Sp. Gr.
1.........	91.50	1.406	11.........	89.36	1.416
2.........	91.50	1.407	12.........	87.73	1.422
3.........	98.10	1.440	13.........	89.77	1.417
4.........	79.93	1.414	14.........	70.84	1.463
5.........	75.47	1.414	15.........	69.40	1.463
6.........	83.97	1.417	16.........	87.67	1.412
7.........	82.75	1.416	17.........	109.99	1.427
8.........	86.41	1.415	18.........	93.17	1.431
9.........	84.11	1.416	19.........	89.75	1.409
10.........	87.19	1.417	20.........	91.31	1.421

From a study of this table it is seen that within small limits θ is independent of the specific gravity of the solution. Nos. 14 and 15 were grape sugar, and the specific gravity is much higher here than in the glucose, while the value of θ is much less.

Where the increase in density, however, is considerable, as in 3 and 17, there is also a marked increase in the value of θ, although this increase is not proportional to the increment of specific gravity. In masses of homogeneous nature and structure we should expect *a priori* that θ would always be proportional to the density of the body, *i. e.*, to the amount of optically active matter in a unit number of grammes.

It is thus seen without further argument that commercial glucoses are not optically homogeneous, even when made in the same factory and by processes which do not sensibly vary.

A further study of these optical reactions convinced me that the rotatory power of commercial glucose increased as the percentage of reducing substance diminished.

The following table shows the value of Θ and the corresponding percentage of reducing matter as obtained by Fehling's solution.

TABLE II.

No.	Θ	% Glucose.	No.	Θ	% Glucose.
1.........	91.50	53.20	11.........	89.63	53.50
2.........	91.50	52.36	12.........	87.73	56.49
3.........	98.10	54.60	13.........	89.77	52.36
4.........	79.93	61.73	14.........	70.84	69.93
5.........	75.47	62.50	15.........	69.40	69.30
6.........	83.97	59.35	16.........	87.67	56.34
7.........	82.75	61.40	17.........	109.99	39.22
8.........	86.41	58.80	18.........	93.17	57.14
9.........	84.11	58.55	19.........	89.75	54.37
10.........	89.19	55.60	20.........	91.31	56.81

It will be seen by the above table that as the per cent

of reducing matter increases, the value of θ diminishes, and *vice versa*. Nos. 14 and 17 show extreme cases of this law. Nos. 3, 18 and 20, because of their high specific gravities, should not be included in the above generalization. Having thus established the law that the per cent of reducing matter is in general inversely as the value of θ, it is next proposed to investigate the relation between these two quantities, and determine whether it is constant or variable.

From Nos. 1 and 2, of table II, it is seen that for a value of $\theta = 91.50$, the percentage of reducing matter is 52.78. Let us say for convenience in calculation that $\theta = 91.50$ corresponds to reducing substance = 53 per cent. Let us consider next, some of the cases which the value of θ differs widely from 91.50. No. 17 of above table affords an example.

The difference is, 109.99—91.50 = 18.49. The difference in the per cent of reducing substance is 53—39.22 = 13.78. Thus an excess of the value of θ of 18.49 corresponds to a deficit of 13.78 in the percentage of reducing matter.

Therefore a variation of each degree in the value of θ is equivalent to 0.745 in the percentage of a reducing matter. By similar calculations with the other data furnished by the table, I have found, not including Nos. 3, 18 and 20, marked by the high specific gravity, that this number lies between 75 and 78.

I will give the calculation for the first of these numbers, and compare them with the numbers obtained by analysis.

TABLE III.

NUMBER.	Variation of Θ	% Glucose by 0.75 Factor.	% Glucose by Fehling's Sol.
1	0.00	53.00	53.20
2	0.00	53.00	52.36
3	—12.08	62.06	61.73
4	—16.03	65.03	62.50
5	— 7.53	58.64	59.35
6	— 8.75	59.57	61.40
7	— 5.07	56.81	58.80
8	— 7.44	58.58	58.55
9	— 4.30	56.21	56.60
10	— 2.14	54.62	53.50
11	— 3.77	55.82	56.49
12	— 1.73	54.29	56.18
13	—20.66	58.32	69.93
14	—22.10	69.56	69.30
15	— 3.83	55.88	56.09
16	+18.49	39.14	39.22
17	— 1.75	54.32	54.05
18	— 0.19	53.14	56.81
19	+ 6.60	47.15	54.60
20	+ 1.66	51.75	57.14

In the above table, Nos. 18, 19 and 20 are the three specimens with high specific gravity. We will, therefore, exclude them from the discussion. In the other numbers the percentage of reducing matter, as calculated from the reading of the polariscope, falls short of the amount obtained by the alkaline copper test ten times, and by an average of 1.018. It exceeds that amount seven times with an average of 0.75. We thus see that the polariscope will enable us to compute the reducing matter present in a glucose with a probable error of less than one per cent. This is quite accurate enough for practical purposes.

Perhaps a larger number of determinations should be made before constructing a formula for determining the amount of reducing in substance a "straight" glucose. The following formulæ, however, are given provisionally, subject to some slight correction derived from more extended data.

We may have three cases :

1. The value of $\Theta = 91.50$
2. " " < 91.50
3. " " > 91.50

In the first case the percentage of reducing substance in a glucose, if not far from 1.410 sp. gr., will be nearly 53.

In the second case the required percentage may be found by the following formula, in which a = difference between the value of θ and 91.50, and g = per cent reducing required—

$$g = 53 + 0.75\,a \text{ or } 0.78\,a.$$

In the third case we have

$$g = 53 - 0.75\,a \text{ or } 0.78\,a.$$

In order to make the principle of more general application, I have modified the calculations so as to apply the formula directly to the cane sugar scale of the instrument.

To this end, for instruments using 26.048 grammes for 100 divisions, it is convenient to use only 10 grms. of the glucose. If 26.048 grms. are employed, the neutral point is thrown entirely beyond the limit of the scale. Ten grammes is the quantity which has been employed in the following table.

The average reading of the sugar scale for ten grammes is about 50.

In the following table will be found the results of the experiments.

TABLE IV.

NUMBER.	Scale.	% Reducing Substance by Calculation.	% Same by Cu. Test.	Difference.
1	52.65	53.43	53.20	+0.23
2	52 65	53 43	52.36	+1.07
3	46.07	61.66	61.73	—0.07
4	43.05	64.90	62.50	+2.40
5	48.04	58.75	59.35	—0.60
6	47.70	59.63	61.40	—1.77
7	49.80	57.00	58.80	—1.80
8	48.45	58.56	58.55	+0.01
9	50.26	56.45	55.60	+0.85
10	51.50	54.88	53.50	+1.30
11	50.57	56.04	56.49	—0.45
12	51.74	54.58	56.18	—1.60
13	40.83	68.21	69.93	—1.72
14	40.00	69.25	69.80	—0.05
15	50.53	56.09	56.34	—0.27
16	63.80	39.50	39.22	+0.28
17	51.73	54.37	54.05	+0.32
18	52.63	53.46	56.81	
19	56.53	48.59	54.60	
20	53.70	52.10	57.14	

The above calculations were made from the following data.

Starting with Nos. 1 and 2, and discarding small fractions, we find that 53 divisions of the cane sugar scale correspond to 53 per cent of reducing matter nearly.

By a method of calculation entirely similar to that employed in determining the reducing matter from the fluctuations of Θ, I have found that a variation of one degree in the sugar scale corresponds to an inverse variation of nearly 1.25 per cent of reducing substance.

We may have as in the previous calculation three cases.

1st. The reading of the scale = 53
2d. " " " " > 53
3d. " " " " < 53

In the first case 53 = 58 per cent nearly.

In the second case, placing a for the reading of the scale, we have

$$g = 53 - (a - 53)\ 1.25$$

In the third case we have

$$g = 53 + (53 - a)\ 1.25$$

In seven of the first seventeen cases the percentage of reducing substance calculated by the above formula, exceeded that given by the copper test, and by a mean amount of 0.539.

In ten of them it fell short, and by a mean amount of 0.938. This method, therefore, can be relied upon to give results which do not vary from the copper test except by a small amount.

Not much more in the way of accuracy can be claimed for the copper test itself.

In Nos. 18, 19 and 20 we have again the cases where the high specific gravities vitiate the results of the calculation.

CORRECTION FOR SPECIFIC GRAVITY.

I next proceeded to find out a method for correcting the reading of the polariscope for variations, caused by changes in the specific gravity of the specimens. First I determined the percentage of water in glucose of different specific gravities; following are the results:

I.

Sp. gr.	=	1.440
Weight taken	=	5.515. in Pt. dish.
Loss	=	0.35, at 170°, 2 hours.
Per cent H_2O	=	0.35 ÷ 5.515 = 6,37.

II.

Sp. gr.	=	1.431
Weight taken	=	5.86
Loss	=	0.53, 170°, 2 hours.
Per cent H_2O	=	0.53 ÷ 5.89 = 9.05.

III.

Sp. gr.	=	1.409
Weight taken	=	4.038
Loss	=	0.622, 170°, 3 hours.
Per cent H_2O	=	15.40

IV.

Sp. gr.	=	1.416
Weight taken	=	4.425
Loss	=	0.525, 170°, 2 hours.
Per cent H_2O	=	11.93

V.

Sp. gr.	=	1.417
Weight taken	=	8.639
Loss	=	1.091, 170°, 3 hours.
Per cent H_2O	=	12.70

VI.

SOLID GRAPE SUGAR.

Sp. gr.	=	1.463
Weight taken	=	7.215, 170°, 3 hours.
Loss	=	0.61
Per cent H_2O	=	9.29

These data are scarcely sufficient to establish a rule for correction for variations in specific gravity, but it appears from them that the formulæ will not vary much from the following:

The rule, 53 divisions = 53 per cent, seems applicable to samples in which the percentage of H_2O is 12 to 14, and of which the sp. gr. is from 1.409 to 1.414. For each variation of 0.001 in the specific gravity, the percentage of H_2O varies about 0.3.

Thus if we take the two extreme cases, viz.: 6.37 and 15.14 per cent of H_2O, we find the corresponding specific gravities to be 1.440 and 1.409, a difference of 0.031.

The difference in the percentage of water is 9.03. The quotient of 0.0903 ÷ 0.031 = 3 nearly.

Let us apply these data to the correction of Nos. 18, 19 and 20 in table IV. I give below these numbers and also their corrections.

TABLE V.

NUMBER.	Scale.	% Reducing Substance by Calculation.	Same Corrected.	Same by Cu. Sol.
18	52.63	53.46	55.83	56.81
19	56.53	48.59	55.17	54.60
20	53.70	52.10	56.55	51.14

The above corrections were based on the supposition that 53 divisions of the scale correspond to 53 per cent reducing matter, when the sp. gr. = 1.409, and the percentage of water 15.

We may therefore construct the following provisional formulæ for estimating the correction to be applied to the reading of the scale when the sp. gr. of the specimen varies much from 1.409.

Let a = reading of scale.
" a' = corrected reading.
" ε = sp. gr. of the sample.

Then $a' = a - 3a(\varepsilon - 1.409)$, when the sp. gr. is greater than 1.409, and $a' = a + 3a(1.409 - \varepsilon)$, when ε is less than 1.409.

I next propose to undertake some investigations to show the nature and number of the optically active principles present in glucose.

THE UNITY OF NATURE.

BY THE DUKE OF ARGYLL.

X.

THE ORIGIN OF RELIGION CONSIDERED IN THE LIGHT OF THE UNITY OF NATURE.

(Concluded.)

IN the beginning of this chapter I have observed how little we think of the assumptions which are involved in putting such questions as that respecting the origin of Religion. And here we have come to a point in our investigations at which it is very needful to remember again what some of these assumptions are. In order to do so let us look back for a moment and see where we stand.

We have found the clearest evidence that there is a special tendency in religious conceptions to run into developments of corruption and decay. We have seen the best reasons to believe that the religion of savages, like their other peculiarities, is the result of this kind of evolution. We have found in the most ancient records of the Aryan language proof that the indications of religious thought are higher, simpler, and purer as we go back in time, until at last, in the very oldest compositions of human speech which have come down to us, we find the Divine Being spoken of in the sublime language which forms the opening of the Lord's Prayer. The date in absolute chronology of the oldest Vedic literature does not seem to be known. Professor Max Müller, however, considers that it may possibly take us back 5000 years.[1] This is probably an extreme estimate, and Professor Monier Williams seems to refer the most ancient Vedic hymns to a period not much more remote than 1500 B. C.[2] But whatever that date may be, or the corresponding date of any other very ancient literature, such as the Chinese, or that of the oldest Egyptian papyri, when we go beyond these dates we enter upon a period when we are absolutely without any historical evidence whatever, not only as to the history of Religion, but as to the

[1] Hibbert Lectures, p. 216.
[2] "Hinduism," p. 19.

history and condition of Mankind. We do not know even approximately the time during which he has existed. We do not know the place or the surroundings of his birth. We do not know the steps by which his knowledge "grew from more to more." All we can see with certainty is that the earliest inventions of Mankind are the most wonderful that the race has ever made. The first beginnings of human speech must have had their origin in powers of the highest order. The first use of fire and the discovery of the methods by which it can be kindled; the domestication of wild animals; and above all the processes by which the various cereals were first developed out of some wild grasses—these are all discoveries with which in ingenuity and in importance no subsequent discoveries may compare. They are all unknown to history—all lost in the light of an effulgent dawn. In speculating, therefore, on the origin of these things, we must make one or other of two assumptions—either that Man always had the same mental faculties and the same fundamental intellectual constitution that he has now, or that there was a time when these faculties had not yet risen to the level of Humanity, and when his mental constitution was essentially inferior.

On the first of these assumptions we proceed on the safe ground of inquiry from the known to the unknown. We handle a familiar thing; we dissect a known structure; we think of a known agency. We speculate only on the matter of its first behavior. Even in this process we must take a good deal for granted—we must imagine a good deal that is not easily conceivable. I we try to present to our own minds any distinct image of the first Man, whether we supposed him to havef been specially created or gradually developed, we shall soon find that we are talking about a Being and about a condition of things of which science tells us nothing, and of which the imagination even cannot form any definite conception. The temptation to think of that Being as a mere savage is very great, and this theory underlies nine-tenths of all speculations on the subject. But, to say the very least, this may not be true, and valid reasons have been adduced to show that it is in the highest degree improbable. That the first Man should have been born with all the developments of savagery is as impossible as that he should have been born with all the developments of civilization. The next most natural resource we have is to think of the first Man as something like a child. But no man has ever seen a child which never had a parent, or some one to represent a parent. We can form no picture in our mind's eye of the mental condition of the first Man, if we suppose him to have had no communication with, and no instruction from, some Intelligence other than his own. A child that has never known anything, and has never seen example, is a creature of which we have no knowledge, and of which therefore we can form no definite conception. Our power of conceiving things is, of course, no measure of their possibility. But it may be well to observe where the impossibilities of conception are, or may be, of our own making. It is at least possible that the first Man may not have been born or created in the condition which we find to be so inconceivable. He may have been a child, but having, what all other children have, some intimations of Authority and some acquaintance with its Source. At all events, let it be clearly seen that the denial of this possibility is an assumption; and an assumption too which establishes an absolute and radical distinction between childhood as we know it, and the inconceivable conditions of a childhood which was either without Parents, or with Parents who were comparatively beasts. Professor Max Müller has fancied our earliest forefathers as creatures who at first had to be "roused and awakened from mere staring and stolid wonderment," by certain objects "which set them for the first time musing, pondering, and thinking on the visions floating before their eyes." This is a picture evidently framed on the assumption of a Fatherless childhood—of a Being born into the world with all the innate powers of Man, but absolutely deprived of all direct communication with any Mind or Will analogous to his own. No such assumption is admissible as representing any reasonable probability. But at least such imaginings as these about our first parents have reference to their external conditions only, and do not raise the additional difficulties involved in the supposition that the first Man was half a beast.

Very different is the case upon the other of the two assumptions which have been indicated above. On the assumption that there was a time when Man was different in his own proper nature from that nature as we know it now—when he was merely an animal not yet developed into a Man—on this assumption another element of the unknown is introduced, which is an element of absolute confusion. It is impossible to found any reasoning upon data which are not only unknown, but are in themselves unintelligible and inconceivable. Now it seems as if many of those who speculate on the origin of Religion have not clearly made up their minds whether they are proceeding on the first of these assumptions or on the second; that is to say, on the assumption that Man has always been, in respect to faculty, what he now is, or on the assumption that he was once a beast. Perhaps, indeed, it would be strictly true to say that many of those who speculate on the origin of Religion proceed upon the last of these assumptions without avowing it, or even without distinctly recognizing it themselves. It may be well, therefore, to point out here that on this assumption the question cannot be discussed at all. We must begin with Man as Man, when his development or his creation had made him what he is; not indeed as regards the acquisitions of experience or the treasures of knowledge, but what he is in faculty and in power, in the structure and habit of his mind, in the instincts of his intellectual and moral nature.

But, as we have also seen at the beginning of this chapter, there are two other assumptions between which we must choose. Besides assuming something as to the condition and the powers of the first Man, we must also make one or other of two assumptions as to the existence or non-existence of a Being to whom his mind stands in close relation. One is the assumption that there is no God; and then the problem is, how Man came to invent one. The other is that there is a God; and then the question is, whether He first formed, and how long He left, His creature without any intuition or revelation of Himself?

It is really curious to observe in many speculations on the origin of Religion how unconscious the writers are that they are making any assumption at all on this subject. And yet in many cases the assumption distinctly is that, as an objective reality, God does not exist, and that the conception of such a Being is built up gradually out of wonderings and guessings about "the Infinite" and "the Invisible."

On this assumption I confess that it does not appear to me to be possible to give any satisfactory explanation of the origin of Religion. As a matter of fact, we see that the tendency to believe in divine or superhuman Beings is a universal tendency in the human mind. As a matter of fact, also, we see that the conceptions which gather round this belief—the ideas which grow up and are developed from one consequence to another respecting the character of these superhuman Personalities and the relations to mankind—are beyond all comparison the most powerful agencies in molding human nature for evil or for good. There is no question whatever about the fact that the most terrible and destructive customs of barbarian and of savage life are customs more or less directly connected with the growth of religious superstitions. It was the perception of this fact which inspired the intense hatred of Religion, as it was known to

him, which breathes in the memorable poem of Lucretius. In all literature there is no single line more true than the famous line—"Tantum religio potuit suadere malorum." Nor is it less certain, on the other hand, that the highest type of human virtue is that which has been exhibited in some of those whose whole inspiration and rule of life has been founded on religious faith. Religious conceptions have been historically the centre of all authority, and have given their strength to all ideas of moral obligation. Accordingly, we see that the same hatred which inspired Lucretius against Religion because of its power for evil, now inspires other men against it because of its power for good. Those who wish to sever all the bonds which bind human society together, the State, the Church, the Family, and whose spirits are in fierce rebellion against all Law, human or divine, are and must be bitter enemies of Religion. The idea must be unendurable to them of a Ruler who cannot be defied, of a Throne which cannot be overturned, of a Kingdom which endureth throughout all generations. The belief in any Divine Personality as the source of the inexorable laws of Nature is a belief which enforces, as nothing else can enforce, the idea of obligation and the duty of obedience.

It is not possible, in the light of the unity of Nature, to reconcile this close and obvious relation between religious conceptions and the highest conditions of human life with the supposition that these conceptions are nothing but a dream. The power exercised over the mind and conduct of Mankind, by the belief in some Divine Personality with whom they have to do, is a power of having all the marks that indicate an integral part of the system under which we live. But if we are to assume that this belief does not represent a fact, and that its origin is any other than a simple and natural perception of that fact, then this negation must be the groundwork of all speculations on the subject, and must be involved, more or less directly, in every argument we use. But even on this assumption it is not a reasonable explanation of the fundamental postulates of all Religion—namely, the existence of superhuman Beings—to suppose that the idea of personality has been evolved out of that which is impersonal; the idea of Will out of that which has no Intelligence; the idea of life out of that which does not contain it.

On the other hand, if we make the only alternative assumption—namely, that there is a God, that is to say, a Supreme Being, who is the Author of creation,—then the origin of man's perception of this fact ceases to have any mystery other than that which attaches to the origin of every one of the elementary perceptions of his mind and spirit. Not a few of these perceptions tell him of realities which are as invisible as the Godhead. Of his own passions his perception is immediate—of his own love, of his own anger, of his own possession of just authority. The sense of owing obedience may well be as immediate as the sense or a right to claim it. Moreover, seeing the transcendent power of this perception upon his conduct, and, through his conduct, upon his fate, it becomes antecedently probable, in accordance with the analogies of Nature and of all other created Beings, that from the very first, and as part of the outfit of his nature, some knowledge was imparted to him of the existence of his Creator, and of the duty which he owed to Him.

Of the methods by which this knowledge was imparted to him, we are as ignorant as of the methods by which other innate perceptions were implanted in him. But no special difficulty is involved in the origin of a perception which stands in such close relation to the unity of Nature. It has been demanded, indeed, as a postulate in this discussion, that we should discard all notions of antecedent probability—that we should take nothing for granted, except that Man started on his course furnished with what are called his senses, and with nothing more. And this demand may be acceded to, provided it be well understood what our senses are. If by this word we are to understand nothing more than the gates and avenues of approach through which we derive an impression of external objects—our sight, and touch, and smell, and taste, and hearing—then, indeed, it is the most violent of all assumptions that they are the only faculties by which knowledge is acquired. There is no need to put any disparagement on these senses, or to undervalue the work they do. Quite the contrary. It has been shown in a former chapter how securely we may rest on the wonder and on the truthfulness of these faculties as a pledge and guarantee of the truthfulness of other faculties which are conversant with higher things. When we think of the mechanism of the eye, and of the inconceivable minuteness of the ethereal movements which that organ enables us to separate and to discriminate at a glance, we get hold of an idea having an intense interest and a supreme importance. If adjustments so fine and so true as these have been elaborated out of the unities of Nature, whether suddenly by what we imagine as Creation, or slowly by what we call Development, then may we have the firmest confidence that the same law of natural adjustment has prevailed in all the other faculties of the perceiving and conceiving mind. The whole structure of of that mind is, as it were, revealed to be a structure which is in the nature of a growth—a structure whose very property and function it is to take in and assimilate the truths of Nature—and that in an ascending order, according to the rank of those truths in the system and constitution of the Universe. In this connection of thought too great stress cannot be laid on the wonderful language of the senses. In the light of it the whole mind and spirit of Man becomes one great mysterious retina for reflecting the images of Eternal Truth. Our moral and intellectual preceptions of things which, in their very nature, are invisible, come home to us as invested with a new authority. It is the authority of an adjusted structure—the mental organization of which has been molded by what we call natural causes—these being the causes on which the unity of the world depends.

And when we come to consider how this molding, and the molding of the human body, deviates from that of the lower animals, we discover in the nature of this deviation a law which cannot be mistaken. That law points to the higher power and to the higher value in his economy of faculties which lie behind the senses. The human frame diverges from the frame of the brutes, so far as the mere bodily senses are concerned, in the direction of greater helplessness and weakness. Man's sight is less piercing than the eagle's. His hearing is less acute than the owl's or the bat's. His sense of smell may be said hardly to exist at all when it is compared with the exquisite susceptibilities of the deer, of the weasel, or of the fox. The whole principle and plan of structure in the beasts which are supposed to be nearest to him in form, is a principle and a plan which is almost the converse of that on which his structure has been organized. The so-called man-like Apes are highly specialized; Man on the contrary is as highly generalized. They are framed to live almost entirely on trees, and to be dependent on arboreal products, which only a very limited area in the globe can supply. Man is framed to be independent of all local conditions, except indeed those extreme conditions which are incompatible with the maintenance of organic life in any form. If it be true, therefore, that he is descended from some "arboreal animal with pointed ears," he has been modified during the steps of that descent on the principle of depending less on senses such as the lower animals possess, and more and more on what may be called the senses of his mind. The unclothed and unprotected condition of the human body, the total abscence of any organic weapon of defense, the want of teeth adapted even for prehension, and the same want of power for similar purposes in the hands and fingers—these are all changes and departures from the mere animal type which stand in obvious relation to the mental

powers of Man. Apart from these, they are changes which would have placed the new creature at a hopeless disadvantage in the struggle for existence. It is not easy to imagine—indeed, we may safely say that it is impossible to conceive—the condition of things during any intermediate steps in such a process. It seems as if there could be no safety until it had been completed—until the enfeebled physical organization had been supported and reinforced by the new capacities for knowledge and design. This, however, is not the point on which we are dwelling now. We are now speculating on the origin of Man. We are considering him only as he is, and as he must have been since he was Man at all. And in that structure as it is, we see that the bodily senses have a smaller relative importance than in the beasts. To the beasts theses sense tell them all they know. To us they speak but little compared with all that our spirit of interpretation gathers from them. But that spirit of interpretation is in the nature of a sense. In the lower animals every external stimulus moves to some appropriate action. In Man it moves to some appropriate thought. This is an enormous difference; but the principle is the same. We can see that, so far as the mechanism is visible, the plan or the principle of that mechanism is alike. The more clearly we understand that this organic mechanism has been a growth and a development, the more certain we may be that in its structure it is self-adapted, and that in its working it is true. And the same principle applies to those other faculties of our mental constitution which have no outward organ to indicate the machinery through which their operations are conducted. In them the spirit of interpretation is in communication with the realities which lie behind phenomena—with energies which are kindred with its own. And so we come to understand that the processes of Development or of Creation, whatever they may have been, which culminated in the production of a Being such as Man, are processes wholly governed and directed by a law of adjustment between the higher truths which it concerns him most to know, and the evolution of faculties by which alone he could be enabled to apprehend them. There is no difficulty in conceiving these processes carried to the most perfect consummation, as we do see them actually carried to very high degrees of excellence in the case of a few men of extraordinary genius, or of extraordinary virtue. In science the most profound conclusions have been sometimes reached without any process of conscious reasoning. It is clearly the law of our nature, however, that the triumphs of intellect are to be gained only by laborious thought, and by the gains of one generation being made the starting-point for the acquisition of the next. This is the general law. But it is a law which itself assumes certain primary intuitions of the mind as the starting-point of all. If these were wrong, nothing could be right. The whole processes of reasoning would be vitiated from the first. The first man must have had these as perfectly as we now have them, else the earliest steps of reason could never have been taken, the earliest rewards of discovery could never have been secured. But there is this great difference between the moral and the intellectual nature of Man, that whereas in the work of reasoning the perceptions which are primary and intuitive require to be worked out and elaborately applied, in morals the perceptions which are primary are all in all. It is true that here also the applications may be infinite, and the doctrines of Utility have their legitimate application in enforcing, by the sense of obligation, whatever course of conduct Reason may determine to be the most fitting and the best. The sense of obligation in itself is, like the sense of logical sequence, elementary, and, like it, is part and parcel of our mental constitution. But unlike the mere sense of logical sequence, the sense of moral obligation has one necessary and primary application which from the earliest moment of Man's existence may well have been all-sufficient. Obedience to the will of legitimate Authority is, as we have seen in a former chapter, the first duty and the first idea of duty in the mind of every child. If ever there was a man who had no earthly father, or if ever there was a man whose father was, as compared with himself, a beast, it would seem a natural and almost a necessary supposition that, along with his own new and wonderful power of self-consciousness, there should have been associated a consciousness also of the presence and the power of that Creative Energy to which his own development was due. It is not possible for us to conceive what form the consciousness would take. "No man hath seen God at any time." This absolute declaration of one of the Apostles of the Christian Church proves that they accepted, as metaphorical, the literal terms in which the first communications between Man and his Creator are narrated in the Jewish Scriptures. It is not necessary to suppose that the Almighty was seen by His first human creature walking in bodily form in a garden "in the cool of the day." The strong impressions of a spiritual Presence and of spiritual communications which have been the turning-point in the lives of men living in the bustle of a busy and corrupted world, may well have been even more vivid and more immediate when the first "Being worthy to be called a man" stood in this world alone. The light which shone on Paul of Tarsus on the way to Damascus may have been such a light as shone on the father of our race; or the communication may have been what metaphysicians call purely subjective, such as in all ages of the world do sometimes "flash upon that inward eye which is the bliss of solitude." But none the less may they have been direct and overpowering. The earliest and simplest conception of the Divine Nature might well also be the best. And although we are forbidden to suppose the embodiment and visibility of the Godhead, we are not driven to the alternative of concluding that there never could have been anything which is to us unusual in the intimations of His presence. Yet this is another of the unobserved assumptions which are perpetually made—the assumption of an uniformity in Nature which does not exist. That "all things have continued as they are since the beginning" is conceivable. But that all things should have continued as they were since before the beginning is a contradiction in terms. In primeval times many things had then just been done of which we have no knowledge now. When the form of Man had been fashioned and completed for the first time, like and yet unlike to the bodies of the beasts; when all their organs had been lifted to a higher significance in his; when his hands had been liberated from walking and from climbing, and had been elaborated into an instrument of the most subtle and various use; when his feet had been adapted for holding him in the erect position; when his breathing apparatus had been set to musical chords of widest compass and the most exquisite tones; when all his senses had become ministers to a mind endowed with wonder and with reverence, and with reason and with love—then a work had been accomplished such as the world had not known before, and such as has never been repeated since. All the conditions under which that work was carried forward must have been happy conditions—conditions, that is to say, in perfect harmony with its progress and its end. They must have been favorable, first, to the production and then to the use of those higher faculties which separated the new creature from the beasts. They must have been in a corresponding degree adverse to the incompatible with the prevalence of conditions tending to reversion or to degradation in any form. That long and gradual ascent, if we assume it to have been so,—or, as it may have been, that sudden transfiguration,—must have taken place in a congenial air and amid surroundings which lent themselves to so great a change. On every conceivable theory, therefore, of the origin of Man, all this seems a necessity of thought.

But perhaps it seems on the Theory of Development even more a necessity than on any other. It is of the essence of that theory that all things should have worked together for the good of the Being that was to be. On the lowest interpretation, this "toil co-operant to an end" is always the necessary result of forces ever weaving and ever interwoven. On the higher interpretation it is the same. Only, some Worker is ever behind the work. But under either interpretation the conclusion is the same. That the first man should have been a savage, with instincts and dispositions perverted as they are never perverted among the beasts, is a supposition impossible and inconceivable. Like every other creature, he must have been in harmony with his origin and his end—with the path which had led him to where he stood, with the work which made him what he was. It may well have been part of that work—nay, it seems almost a necessary part of it—to give to this new and wonderful Being some knowledge of his whence and whither—some open vision, some sense and faculty divine.

With arguments so deeply founded on the analogies of Nature in favor of the conclusion that the first Man, though a child in acquired knowledge, must from the first have had instincts and intuitions in harmony with his origin and with his destiny, we must demand the clearest proof from those who assume that he could have had no conception of a Divine Being, and that this was an idea which could only be acquired in time from staring at things too big for him to measure, and from wondering at things too distant for him to reach. Not even his powers could extract from such things that which they do not contain. But in his own Personality, fresh from the hand of Nature,—in his own spirit just issuing from the fountains of its birth,—in his own Will, willing according to the law of its creation,—in his own desire of knowledge,—in his own sense of obligation,—in his own wonder and reverence and awe,—he had all the elements to enable him at once to apprehend, though not to comprehend, the Infinite Being who was the Author of his own.

It is, then, with that intense interest which must ever belong to new evidence in support of fundamental truths that we find these conclusions, founded as they are on the analogies of Nature, confirmed and not disparaged by such facts as can be gathered from other sources of information. Scholars who have begun their search into the origin of Religion in the full acceptance of what may be called the savage theory of the origin of Man--who, captivated by a plausible generalization, had taken it for granted that the farther we go back in time, the more certainly do we find all Religion assuming one or other of the gross and idolatrous forms which have been indiscriminately grouped under the designation of Fetishism—have been driven from this belief by discovering to their surprise that facts do not support the theory. They have found, on the contrary, that up to the farthest limits which are reached by records which are properly historical, and far beyond those limits to the remotest distance which is attained by evidence founded on the analysis of human speech, the religious conceptions of men are seen as we go back in time to have been not coarser and coarser, but simpler, purer, higher—so that the very oldest conceptions of the Divine Being of which we have any certain evidence are the simplest and best of all.

In particular, and as a fact of typical significance, we find very clear indications that everywhere Idolatry and Fetishism appear to have been corruptions, whilst the higher and more spiritual conceptions of Religion which lie behind do generally even now survive among idolatrous tribes as vague surmises or as matters of speculative belief. Nowhere even now, it is confessed, is mere Fetishism the whole of the Religion of any people. Everywhere, in so far as the history of it is known, it has been the work of evolution, the development of tendencies which are deviations from older paths. And not less significant is the fact that everywhere in the imagination and traditions of Mankind there is preserved the memory and the belief in a past better than the present. "It is a constant saying," we are told, "among African tribes that formerly heaven was nearer to man than it is now; that the highest God, the Creator Himself, gave formerly lessons of wisdom to human beings; but that afterwards He withdrew from them, and dwells now far from them in heaven." All the Indian races have the same tradition; and it is not easy to conceive how a belief so universal could have risen unless as a survival. It has all the marks of being a memory and not an imagination. It would reconcile the origin of Man with that law which has been elsewhere universal in creation—the law under which every ceature has been produced not only with appropriate powers, but with appropriate instincts and intuitive perceptions for the guidance of these powers in their exercise and use. Many will remember the splendid lines in which Dante has defined this law, and has declared the impossibility of Man having been exempt therefrom :—

> Nell' ordine ch'io dico sono accline
> Tutte nature per diverse sorti
> Più al principio loro, e men vicine;
> Onde si muovono a diversi porti
> Per lo gran mar dell' essere; e ciascuna
> Con istinto a lei dato che la porti.
>
> * * * * *
>
> Nè pur le creature, che son fuore
> D'intelligenzia, quest'arco saetta,
> Ma quelle c'hanno intelletto ed amore.[3]

The only mystery which would remain is the mystery which arises out of the fact that somehow those instincts have in Man not only been liable to fail, but that they seem to have acquired apparently an ineradicable tendency to become perverted. But this is a lesser mystery than the mystery which would attach to the original birth or creation of any breature in the condition of a human savage. It is a lesser mystery because it is of the essence of a Being whose Will is comparatively free that he should be able to deviate from his appointed path. The origin of evil may appear to us to be a great mystery. But this at least may be said in mitigation of the difficulty, that without the possibility of evil there could be no possibility of any virtue. Among the lower animals obedience has always been a necessity. In Man it was raised to the dignity of a duty. It is in this great change that we can see and understand how it is that the very elevation of his nature is inseparable from the possibility of a Fall. The mystery, then, which attaches to his condition now is shifted from his endowments and his gifts to the use he made of them. The question of the origin of Religion is merged and lost in the question of the origin of Man. And that other question, how his Religion came to be corrupted, becomes intelligible on the supposition of wilful disobedience with all its consequences having become "inherited and organized in the race." This is the formula of expression which has been invented or accepted by those who do not believe in original instincts or intuitions, even when these are in harmony with the order and with the reasonableness of Nature. It may well therefore be accepted in a case where we have to account for tendencies and propensities which have no such character—which are exceptions to the unity of Nature, and at variance with all that is intelligible in its order, or reasonable in its law.

If all explanation essentially consists in the reduction of phenomena into the terms of human thought and into the analogies of human experience, this is the explanation which can alone reconcile the unquestionable corruption of human character with the analogies of Creation.

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[3] "Paradiso," canto i. 110-120.

For the present I must bring these papers to a close. If the conclusions to which they point are true, then we have in them some foundation-stones strong enough to bear the weight of an immense, and, indeed, of an immeasurable, superstructure. If the Unity of Nature is not a unity which consists in mere sameness of material, or in mere identity of composition, or in mere uniformity of structure, but a unity which the mind recognizes as the result of operations similar to its own; if man, not in his body only, but in the highest as well as in the lowest attributes of his spirit, is inside this Unity and part of it; if all his powers are, like the instincts of the beasts, founded on a perfect harmony between his faculties and the realities of creation; if the limits of his knowledge do not affect its certainty; if its accepted truthfulness in the lower fields of thought arises out of correspondences and adjustments which are applicable to all the operations of his intellect, and all the energies of his spirit; if the moral character of Man, as it exists now, is the one great anomaly in Nature—the one great exception to its order and to the perfect harmony of its laws; if the corruption of this moral character stands in immediate and necessary connection with rebellion against the Authority on which that order rests; if all ignorance and error and misconception respecting the nature of that Authority and of its commands has been and must be the cause of increasing deviation, disturbance, and perversion, then, indeed, we have a view of things which is full of light. Dark as the difficulties which remain may be, they are not of a kind to undermine all certitude, to discomfit all conviction, and to dissolve all hope. On the contrary, some of these difficulties are seen to be purely artificial and imaginary, whilst many others are exposed to the suspicion of belonging to the same class and category. In some cases our misgivings are shown to be unreasonable, whilst in many other cases, to say the least, doubt is thrown on Doubt. Let destructive criticism do its work. But let that work be itself subjected to the same rigid analysis which it professes to employ. Under the analysis, unless I am much mistaken, the destroyer will be destroyed. That which pretends to be the universal solvant of all knowledge and of all belief, will be found to be destitute of any power to convict of falsehood the universal instinct of Man, that by a careful and conscientious use of the appropriate means he can, and does, attain to a substantial knowledge of the Truth.

ELEMENTS OF COMET (*b*), 1881.

(Communicated by Rear Admiral JOHN RODGERS, Superintendent U. S. Naval Observatory.)

The following elements have been computed by Prof. Frisby, U. S. N., from observations made with the Transit Circle at the Naval Observatory:

Time of perihelion passage, June 16, .37001.

$$\begin{array}{lclll} \pi & = & 265^\circ & 31' & 15.''4 \\ \Omega & = & 270 & 58 & 27 \\ \log q & = & 9.866748 & & \\ \iota & = & 63 & 25 & 55.7 \end{array}$$

MIDDLE PLACE.

$$\begin{array}{lcl} & \text{C} - \text{O} & \\ \delta\lambda\cos\beta & - & 13.''4 \\ \delta\beta & + & 62.1 \end{array}$$

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING AUG. 13, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

AUGUST.	BAROMETER. Mean for the day. Reduced to Freezing.	Maximum. Reduced to Freezing.	Maximum. Time.	Minimum. Reduced to Freezing.	Minimum. Time.	THERMOMETERS. Mean. Dry Bulb.	Mean. Wet Bulb.	Maximum. Dry Bulb.	Time.	Maximum. Wet Bulb.	Time.	Minimum. Dry Bulb.	Time.	Minimum. Wet Bulb.	Time.	Maxi'm In Sun.
Sunday, 7	29.773	29.810	0 a. m.	29.722	2 p. m	73.6	70.6	79	2 p. m.	73	2 p. m.	67	12 p. m.	67	12 p. m.	123.
Monday, 8	29.889	29.910	12 p. m.	29.796	0 a. m.	70.0	65.3	78	5 p. m.	69	7 p. m.	61	5 a. m.	60	5 a. m.	140.
Tuesday, 9	29.794	29.910	0 a. m.	29.632	12 p. m.	74.0	67.7	81	3 p. m.	71	6 p. m.	62	5 a. m.	61	6 a. m.	141.
Wednesday, 10	29.616	29.710	12 p. m.	29.578	5 a. m.	77.3	70.0	86	2 p. m.	74	5 p. m.	64	12 p. m.	62	12 p. m.	141.
Thursday, 11	29.832	29.878	10 a. m.	29.710	0 a. m.	69.7	63.3	78	4 p. m.	67	6 p. m.	59	5 a. m.	58	5 a. m.	139.
Friday, 12	29.803	29.872	7 a. m.	29.700	12 p. m.	74.6	67.6	81	2 p. m.	71	2 p. m.	62	5 a. m.	61	5 a. m.	138.
Saturday, 13	29.560	29.700	0 a. m.	29.498	6 p. m.	81.3	73.7	96	4 p. m.	81	6 p. m.	70	5 a. m.	66	5 a. m.	146.

Mean for the week .... 29.752 inches.
Maximum for the week at 12 p. m., August 8th .... 29.910 "
Minimum " at 7 p. m., August 6th .... 29.498 "
Range .... .412 "

	Dry.		Wet.	
Mean for the week	74.3	degrees	68.3	degrees.
Maximum for the week, at 4 pm. 13th	96.	" at 6 pm 13th,	81.	"
Minimum " " 5 am. 11th	59.	" at 5 am 11th,	58.	"
Range " "	37.	"	23.	"

AUGUST.	WIND. Direction. 7 a. m.	2 p. m.	9 p. m.	Velocity in miles. Distance for the Day.	Force in lbs. per sqr. feet. Max.	Time.	HYGROMETER. Force of vapor. 7 a. m.	2 p. m.	9 p. m.	Relative humidity. 7 a. m.	2 p. m.	9 p. m.	CLOUDS. Clear, 0; Overcast, 10. 7 a. m.	2 p. m.	9 p. m.	RAIN AND SNOW. Depth of rain and snow in inches. Time of Begining.	Time of Ending.	Duration. h. m.	Amount of water	OZONE. 1 / 10
Sunday, 7	s. w.	s. w.	s. w.	187	6¾	4.30 am	.693	.730	.708	85	74	100	8 cu.	8 cir. cu.	5 cir. cu.	3.45am 2.15pm	9 a m. 10 p m	5.15 7.45	.11 .63	10 0
Monday, 8	n.	n. n. w.	s. e.	111	1¼	11.00 pm	.516	.554	.622	83	64	85	1 cir.	5 cu.	0	-----	-----	-----	--	4
Tuesday, 9	w. s. w.	s. w.	s. s. w.	179	4	2.50 pm	.509	.612	.666	74	62	77	5 cir. cu. s	6 cir. cu.	7 cu.	10 p m	10½ pm	0.30	.01	8
Wednesday, 10	w. s. w.	n. n. w.	n. n. w.	246	5¼	1.15 pm	.666	.596	.644	77	48	85	0	3 cu.	0	-----	-----	-----	--	0
Thursday, 11	n. n. w.	n. n. e.	s. s. e.	112	1½	9.10 am	.465	.449	.586	78	52	80	0	0	0	-----	-----	-----	--	1
Friday, 12	w.	s. s. w.	s. s. w.	137	2	5.40 pm	.476	.624	.666	69	59	77	2 cir. s.	7 cir.	1 cu.	-----	-----	-----	--	6
Saturday, 13	w. s. w.	s. w.	n. n. e.	230	3¾	4.00 pm	.608	.768	.829	80	51	78	7 cu.	4 cu.	5 cu.	-----	-----	-----	--	

Distance traveled during the week .... 1,202 miles.
Maximum force .... 6¾ lbs.

Total amount of water for the week .... .75 inch.
Duration of rain .... 13 hours, 30 minutes.

DANIEL DRAPER, Ph. D.

Director Meteorological Observatory of the Department of Public Parks, New York.